WHAT IS CLAIMED IS:

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1. An image distortion correction apparatus comprising:

a circumscribed rectangle extraction unit which extracts a circumscribed rectangle for each

10 character in a distorted image scanned by an image reading unit to read an original placed on a reference plane;

a character string extraction unit which extracts character strings using said circumscribed

15 rectangles extracted by said circumscribed rectangle extraction unit;

a distance estimation unit which estimates a distance between said reference plane and said original using said character strings; and

20 an image distortion correction unit which corrects said distorted image based on said distance between said reference plane and said original estimated by said image distortion correction unit.

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2. The image distortion correction apparatus as claimed in claim 1 further comprising:

5   an original distinction unit which decides whether said original is written horizontally or vertically, wherein in case that said original distinction unit decides that said original is written in the horizontal,

10   said distance estimation unit first, selects character strings each of which has a length longer than a length of a predetermined ratio to that of the longest string out of a plurality of character strings in said distorted image, then,

15 selects one string having the largest curvature out of said selected character strings for a reference character string, and then, estimates a distance between said reference plane and said original using said reference string.

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3. The image distortion correction apparatus as claimed in claim 2, wherein said

25 apparatus as claimed in claim 2, wherein said

curvature is measured based on the location of the
center coordinates in a main scanning direction of
the circumscribed rectangle in the character string,
and the larger a difference between a maximum value

5   of said center coordinates and a minimum value of
said center coordinates, the larger is the said
curvature.

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4.   The image distortion correction
apparatus as claimed in claim 1 further comprising:
an original distinction unit which decides

15   whether said original is written horizontally or
vertically, wherein in case that said original
distinction unit decides that said original is
written in the vertical,
said character string extraction unit

20   extracts a reference character string using
circumscribed rectangles either at a top of or at a
bottom of each vertical line,
said distance estimation unit estimates a
distance between said reference plane and said

25   original using said reference string.

5   5.   The image distortion correction
apparatus as claimed in claim 2, wherein
          said distance estimation unit measures
both a first distance D1 between a prolonged line of
a line part in said reference character string and a
10   curve part in said reference character string and a
second distance D2 between an imaging center line
and said curve part in said reference character
string, and estimates a distance D between said
reference plane and said original based on

15     $D = R \times (D1 / D2)$
, where R is a distance between said reference plane
and a center of a lens.

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          6.   The image distortion correction
apparatus as claimed in claim 3, wherein
          said distance estimation unit measures
25   both a first distance D1 between a prolonged line of

a line part in said reference character string and a
curve part in said reference character string and a
second distance D2 between an imaging center line
and said curve part in said reference character

5   string, and estimates a distance D between said
reference plane and said original based on

$$D = R \times (D1 / D2)$$

, where R is a distance between said reference plane
and a center of a lens.

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15   7.   The image distortion correction
apparatus as claimed in claim 4, wherein
            said distance estimation unit measures
both a first distance D1 between a prolonged line of
a line part in said reference character string and a

20   curve part in said reference character string and a
second distance D2 between an imaging center line
and said curve part in said reference character
string, and estimates a distance D between said
reference plane and said original based on

25      $$D = R \times (D1 / D2)$$

, where R is a distance between said reference plane and a center of a lens.

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8.   The image distortion correction apparatus as claimed in claim 1, wherein said distance estimation unit

10 independently estimates each distance between said reference plane and said original for a left page and a right page.

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9.   An image distortion correction apparatus comprising:

20 a ruled line extraction unit which extracts a ruled lines in a distorted image scanned by an image reading unit to read an original placed on a reference plane;

a distance estimation unit which

25 estimates a distance between said reference plane

and said original using said ruled lines; and

an image distortion correction unit which corrects said distorted image based on said distance between said reference plane and said original

5   estimated by said image distortion correction unit.

10   10.   The image distortion correction apparatus as claimed in claim 9 further comprising:

an original distinction unit which decides whether said original is written horizontally or vertically, wherein in case that said original

15 distinction unit decides that said original is written in the horizontal,

said distance estimation unit first, selects ruled lines each of which has a length longer than a length of a predetermined ratio to

20 that of the longest ruled line out of a plurality of ruled lines in said distorted image, then, selects one ruled line placed nearest an upper edge or a lower edge of the scanned image out of said selected ruled lines for a reference ruled line, and then,

25 estimates a distance between said reference plane

and said original using said reference ruled line.

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      11. The image distortion correction
apparatus as claimed in claim 10, wherein
      said distance estimation unit measures
both a first distance D1 between a prolonged line of

10 a line part in said reference ruled line and a curve
part in said reference ruled line and a second
distance D2 between an imaging center line and said
curve part in said reference ruled line, and
estimates a distance D between said reference plane

15 and said original based on

$$D = R \times (D1 / D2)$$

, where R is a distance between said reference plane
and a center of a lens.

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      12. The image distortion correction
apparatus as claimed in claim 9, wherein

25   said distance estimation unit

independently estimates each distance between said reference plane and said original for a left page and a right page.

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13. A computer readable recording media having a program to execute an image distortion

10 correction method, said program comprising steps of:

a circumscribed rectangle extraction step for extracting a circumscribed rectangle for each character in a distorted image scanned by an image reading step to read an original placed on a

15 reference plane;

a character string extraction step for extracting character strings using said circumscribed rectangles extracted by said circumscribed rectangle extraction step;

20 a distance estimation step for estimating a distance between said reference plane and said original using said character strings; and

an image distortion correction step for correcting said distorted image based on said

25 distance between said reference plane and said

original estimated by said image distortion

correction step.

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      14. The computer readable recording media

as claimed in claim 13 further comprising:

      an original distinction step which decides

10 whether said original is written horizontally or

vertically, wherein in case that said original

distinction step decides that said original is

written in the horizontal,

      said distance estimation step first,

15 selects character strings each of which has a length

longer than a length of a predetermined ratio to

that of the longest string out of a plurality of

character strings in said distorted image, then,

selects one string having the largest curvature out

20 of said selected character strings for a reference

character string, and then, estimates a distance

between said reference plane and said original using

said reference string.

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15. The computer readable recording media as claimed in claim 14, wherein said curvature is measured based on a location of center coordinates in a main scanning direction of the circumscribed rectangle in the character string, and the larger a difference between a maximum value of said center coordinates and a minimum value of said center coordinates, the larger is the said curvature.

16. The computer readable recording media as claimed in claim 13 further comprising:

an original distinction step for deciding whether said original is written horizontally or vertically, wherein in case that said original distinction step decides that said original is written in the vertical,

said character string extraction step extracts a reference character string using circumscribed rectangles either at a top of or at a bottom of each vertical line,

said distance estimation step estimates a distance between said reference plane and said original using said reference string.

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17. The computer readable recording media as claimed in claim 14, wherein

10 said distance estimation step measures both a first distance D1 between a prolonged line of a line part in said reference character string and a curve part in said reference character string and a second distance D2 between an imaging center line

15 and said curve part in said reference character string, and estimates a distance D between said reference plane and said original based on

$$D = R \times (D1 / D2)$$

, where R is a distance between said reference plane

20 and a center of a lens.

25 18. The computer readable recording media

as claimed in claim 15, wherein

said distance estimation step measures both a first distance D1 between a prolonged line of a line part in said reference character string and a

5   curve part in said reference character string and a second distance D2 between an imaging center line and said curve part in said reference character string, and estimates a distance D between said reference plane and said original based on

10      $D = R \times (D1 / D2)$

, where R is a distance between said reference plane and a center of a lens.

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19.   The computer readable recording media as claimed in claim 16, wherein

20   said distance estimation step measures both a first distance D1 between a prolonged line of a line part in said reference character string and a curve part in said reference character string and a second distance D2 between an imaging center line

25   and said curve part in said reference character

string, and estimates a distance D between said
reference plane and said original based on

$$D = R \times (D1 / D2)$$

, where R is a distance between said reference plane
5   and a center of a lens.

10   20. The computer readable recording media
as claimed in claim 13, wherein
            said distance estimation step
independently estimates each distance between said
reference plane and said original for a left page
15 and a right page.

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            21. A computer readable recording media
having a program to execute an image distortion
correction method, said program comprising steps of:
            a ruled line extraction step for
25 extracting ruled lines in a distorted image scanned

by an image reading step to read an original placed
on a reference plane;

a distance estimation step for estimating
a distance between said reference plane and said

5 original using said ruled lines; and

an image distortion correction step for
correcting said distorted image based on said
distance between said reference plane and said
original estimated by said image distortion

10 correction step.

15 22. The computer readable recording media
as claimed in claim 21 further comprising:

an original distinction step for deciding
whether said original is written horizontally or
vertically, wherein in case that said original

20 distinction step decides that said original is
written in the horizontal,

said distance estimation step first,
selects ruled lines each of which has a length
longer than a length of a predetermined ratio to

25 that of the longest ruled line out of a plurality of

ruled lines in said distorted image, then, selects

one ruled line placed nearest an upper edge or a

lower edge of the scanned image out of said selected

ruled lines for a reference ruled line, and then,

5 estimates a distance between said reference plane

and said original using said reference ruled line.

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23. The computer readable recording media

as claimed in claim 22, wherein

said distance estimation step measures

both a first distance D1 between a prolonged line of

15 a line part in said reference ruled line and a curve

part in said reference ruled line and a second

distance D2 between an imaging center line and said

curve part in said reference ruled line, and

estimates a distance D between said reference plane

20 and said original based on

$$D = R \times (D1 / D2)$$

, where R is a distance between said reference plane

and a center of a lens.

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24. The computer readable recording media
as claimed in claim 21, wherein

5   said distance estimation step
independently estimates each distance between said
reference plane and said original for a left page
and a right page.

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25. An image distortion correction
method comprising steps of:

15   a circumscribed rectangle extraction step
for extracting a circumscribed rectangle for each
character in a distorted image scanned by an image
reading step to read an original placed on a
reference plane;

20   a character string extraction step for
extracting character strings using said
circumscribed rectangles extracted by said
circumscribed rectangle extraction step;

a distance estimation step for estimating

25 a distance between said reference plane and said

original using said character strings; and

an image distortion correction step for correcting said distorted image based on said distance between said reference plane and said
5   original estimated by said image distortion correction step.

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26.   An image distortion correction method comprising steps of:

a ruled line extraction step for extracting ruled lines in a distorted image scanned
15 by an image reading unit to read an original placed on a reference plane;

a distance estimation step for estimating a distance between said reference plane and said original using said ruled lines; and

20 an image distortion correction step for correcting said distorted image based on said distance between said reference plane and said original estimated by said image distortion correction step.

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27. An image scanner comprising:

an image reading unit to read an original placed on a reference plane; and

an image distortion correction apparatus comprising;

a circumscribed rectangle extraction unit which extracts a circumscribed rectangle for each character in a distorted image scanned by said image reading unit;

a character string extraction unit which extracts character strings using said circumscribed rectangles extracted by said circumscribed rectangle extraction unit;

a distance estimation unit which estimates a distance between said reference plane and said original using said character strings; and

an image distortion correction unit which corrects said distorted image based on said distance between said reference plane and said original estimated by said image distortion correction unit.

28. An image scanner comprising:

an image reading unit to read an original

5   placed on a reference plane; and

an image distortion correction apparatus

comprising;

a ruled line extraction unit which

extracts ruled lines in a distorted image scanned by

10   said image reading unit;

a distance estimation unit which estimates

a distance between said reference plane and said

original using said ruled lines; and

an image distortion correction unit which

15   corrects said distorted image based on said distance

between said reference plane and said original

estimated by said image distortion correction unit.

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29. An image forming apparatus

comprising:

an image reading unit to read an original

25   placed on a reference plane;

an image distortion correction apparatus comprising;

a circumscribed rectangle extraction unit which extracts a circumscribed rectangle for each

5   character in a distorted image scanned by said image reading unit;

a character string extraction unit which extracts character strings using said circumscribed rectangles extracted by said circumscribed rectangle

10   extraction unit;

a distance estimation unit which estimates a distance between said reference plane and said original using said character strings; and

an image distortion correction unit which

15   corrects said distorted image based on said distance between said reference plane and said original estimated by said image distortion correction unit; and,

a printing unit which prints said

20   corrected image supplied from said image distortion correction apparatus on a paper.

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30.   An image forming apparatus comprising:

an image reading unit to read an original placed on a reference plane;

5   an image distortion correction apparatus comprising;

a ruled line extraction unit which extracts ruled lines in a distorted image scanned by said image reading unit;

10   a distance estimation unit which estimates a distance between said reference plane and said original using said ruled lines; and

an image distortion correction unit which corrects said distorted image based on said distance

15   between said reference plane and said original estimated by said image distortion correction unit; and

a printing unit which prints said corrected image supplied from said image distortion

20   correction apparatus on a paper.